PART III.

THE COST OF MANUFACTURING BAMBOO PAPER-PULP.

1. General remarks.

Points which required to be cleared up.—Up to the present-day no firm has put up a mill in British India in which bamboos are utilized for manufacturing paper-pulp. It has been known, however, for many years that bamboos yield an excellent pulp, a point which has been repeatedly demonstrated by various experts in the laboratory. It is thought that the reasons why no steps have been taken up to the present to utilize bamboos for paper-making on a commercial scale, are that (*i*) persons interested in this subject entertain doubts as to the possibility of obtaining a continuous supply of raw material, at a reasonable price, (*ii*) that, without definite information as to a suitable locality from which to exploit bamboos they are not prepared to take up the subject seriously, (*iii*) that they cannot accept the figures of cost of manufacture based on data obtained in the laboratory only.

In Part IV is given detailed information, for stated localities, of the possible annual outturn and cost of extraction of bamboos which, it is hoped, will definitely clear up these points; in this Part of the report it is proposed to deal with the last point, *i.e.*, cost of manufacture of bamboo-pulp.

Arrangements made for testing bamboos on a commercial scale.—In order to obtain, not an estimated but an actual figure of cost of manufacture, Messrs. F. W. Heilgers, Agents to the Titaghur Paper Mills, who were interested in this subject, addressed the Forest Research Institute in 1910, with a view to obtaining a large quantity of bamboos with which to carry out experiments on a commercial scale. The question of manufacturing pulp from bamboos being under enquiry by the Forest Economist at the time, an agreement was made with the firm to supply them with 20 tons of each of four different species of bamboo, on the understanding that the firm, in return, should give a report on the results obtained by them from their experiments. The results obtained by boiling the 80 tons of bamboos supplied to the firm will be dealt with hereafter.

2. Various processes by which the raw material may be converted into pulp.

Various processes for treating raw material.—There are four methods by which the raw material may be reduced to pulp, namely, by the sulphite, sulphate, and caustic soda processes and also by mechanical treatment. In connection with bamboo, the first process has been tried but bamboo sulphite pulp is extremely difficult to bleach, which renders the process unworkable on a commercial scale. The preparation of mechanical bamboo-pulp, so far as is known, has never been attempted and it is highly improbable that it could ever be prepared in this way. We are therefore only concerned with the sulphate and caustic soda processes. The former has been tried on a laboratory scale by Raitt, and he has obtained slightly better results by this process than those obtained with caustic soda. The results of his work are fully described in his report published in the Indian Forest Records, Volume III, Part III, entitled—"Report on the Investigation of Bamboo as material for Production of Paper-pulp." Whether the results obtained by the sulphate process in a mill will be equal to those obtained with caustic soda and whether the resultant half stuff will prove to be of equal quality, remains to be proved.

3. Species of bamboos for paper-making.

Species of bamboos.—The question of the species of bamboo useful for paper-making has been discussed elsewhere. It is not only a question of the suitability of any given species for the manufacture of pulp but also largely a consideration of the available supply in large quantities, etc., at cheap rates and from suitable localities. The four species dealt with in this report are :—

(1) *Bambusa polymorpha* (Kyathaung).
(2) *Cephalostachyum pergracile* (Tinwa).
(3) *Bambusa arundinacea* (Daugi).
(4) *Melocanna bambusoides* (Muli).

It is with these four species of bamboos that tests have been carried out on a commercial scale.

4. Preparation of the bamboo before treatment.

Nodes and Internodes.—A difficult point to settle was the vexed question of how to deal with the nodes or joints of the bamboo.

Experts up to recent times have been of opinion that the nodes and internodes could not be treated together, and at the time the writer first took up the enquiry, he was of the same opinion. Had it been known from the first that in the case of *B. polymorpha*, and *C. pergracile* both nodes and internodes could be treated together, much labour and time might have been saved. When inspecting the various bamboo areas and at the time of counting and weighing large quantities of bamboos to obtain figures of outturn per acre, the bamboos which were cut for this purpose were further cut into tubes and the nodes and internodes weighed separately. The results obtained are given in the Appendices, and throughout the report mention is made both of the nodes and internodes. To obtain the total weight of the bamboos it is only necessary to add the weight of nodes to that of the internodes, while in the case of B. *arundinacea* and possibly in that of *M. bambusoides* it will be necessary to cut out the nodes before treatment, so that the calculations, based on the internodes only, have been left as they are in the report.

Crushing versus *cutting bamboos before treatment.*—To overcome the difficulty of treating nodes and internodes together, Raitt, in his above-quoted report, advocates crushing the bamboos between rollers and in this way proposes to reduce the material to a tow-like substance. This method has its advantages and disadvantages. The liquor acts more readily on the crushed material resulting in more rapid liberation of the fibre; on the other hand, the material is rendered more bulky and the capacity of a digester is reduced by one-half.* The other method is to chop the material into narrow sections about 1″ long. The results obtained, by treating both nodes and internodes of B. *polymorpha* and *C. pergracile* bamboos, by cutting them into short sections and boiling them in large digesters, have proved most successful.

Washing bamboos before boiling.—Owing to the dust and dirt which is found in bamboos, especially those which have been stored for a considerable time, it has been found necessary to first pass the cut chips through a fanning machine and afterwards to wash them in running water.

Steaming.—Raitt, in his report, advocates treating the bamboos by steaming or boiling them in water before introducing the liquor.

* NOTE.—Since writing the above Raitt has been able to reduce the bulk of the raw material when crushed by a process of fractional distillation.

This is a most important point and one, which it is necessary to carry out, in order to reduce the amount of starch before introducing the liquor, otherwise the percentage of caustic soda required to reduce the raw material to pulp is considerably increased. A period of two hours boiling in water is thought to be sufficient, after which it may be run off and the caustic liquor introduced.

5. Results of boiling bamboos on a commercial scale.

B. polymorpha, "Kyathaung" *bamboos*.—In order to give a correct idea of the results obtained by boiling bamboos on a commercial scale it will be necessary to quote from the report received from the Titaghur Paper Mills. They write as follows :—

> "Our best results with *B. polymorpha* bamboos have been got with our special high pressure digester, which has been recently brought into use. So far we have been able to reduce our caustic to 18 per cent. and bleach quite up to our Government standard with 10 per cent. of 35 per cent. bleaching powder. Time under pressure was one hour at 110 lbs. and five hours at 80 lbs. per square inch. Our yield of pulp showed 46 per cent., caustic and bleach are calculated on the weight of air-dry bamboo. We are handicapped at present for want of a suitable cutter for the bamboo. This will be rectified at an early date, when we hope to still further modify our caustic and bleach."

C. pergracile "Tinwa" *bamboo*.—The following is their report on the trials made with this species :—

"Our trial boils with this species were made in our ordinary fibre digesters, at a pressure of 60 lbs. per square inch. The fibre was boiled with 23 per cent. of 77 per cent. caustic for ten hours. The pulp required 15 per cent. of 35 per cent. bleaching powder to bring it up to our standard of whiteness for Government printing paper. The yield in paper showed 40 per cent. caustic and bleach calculated on air-dry weight of raw material. Several boils were put through on similar lines with variations in time, caustic and pressure but the pulp obtained, under the above conditions, was probably the best of the boils."

They go on to state: "the *C. pergracile* or Tinwa sample lot was all used up in trials at the lower pressure of 60 lbs., but we have no doubt it will give equally good results with *B. polymorpha* under similar treatment."

B. arundinacea, "Daugi" *bamboos*.—Their report on this species runs as follows:—

"This species we boiled for twelve hours with 24 per cent. of caustic and it came out much under-digested. This bamboo is a failure so far as our experiments have gone, but this does not mean that the species is useless for paper-pulp, but that further investigation is necessary, in order to find out the proper method of treatment."

B. arundinacea is an extremely heavy species, with thick walls and heavy nodes, it is very probable that Raitt's method of crushing will have to be resorted to in order to treat this species, and possibly it may also be found necessary to cut out the nodes.

M. bambusoides, "Muli" *bamboos*.—The report on this species runs as follows:—

"We treated this species exactly as in the case of *B. polymorpha*, but the fibre was not fit to make white paper. It gave a good looking pulp, but it would not bleach with a reasonable quantity of bleaching powder. Also small black stringy fibres appeared throughout the pulp, which are most objectionable, as they cannot easily be taken out and would spoil white paper, even if the bleaching difficulty were got over."

It is evident that *Melocanna bambusoides* bamboo will require further testing, before it can be used for paper-pulp.* The question of producing a better colour by bleaching, within economic limits of working, may possibly be overcome by treating this species by the sulphate process. The appearance of dark stringy fibre in the pulp may very likely be due to the black fibre in the nodes, or in the sheath in which case it will be necessary to cut out the joints or get rid of any adherent portions of the sheath.†

6. Cost of manufacturing one ton of air-dried unbleached pulp.

The whole question of manufacturing bamboo-pulp at a profit, that is to say, a pulp capable of being converted into high class printing

* NOTE.—Further tests with this species of bamboo have been arranged for, the bamboos for testing being sent from Arakan.

† NOTE.—It has been ascertained, since writing the above, that the sheath is the cause of the black stringy fibres, and these can easily be cut off before treatment.

paper, depends on the cost of production. Taking the figures arrived at by boiling *Bambusa polymorpha* or Kyathaung bamboo on a commercial scale and the cost of the raw material as given in Part IV, we arrive at the following figures of cost for manufacturing unbleached bamboo-pulp in or near Calcutta.

Calculation based on a 46 per cent. yield on weight of air-dried material obtained by boiling with 18 per cent. caustic.

1. The amount of raw material required to make one ton of air-dried pulp is 2·17 tons. The cost of one ton of air-dried bamboo in Rangoon may, on an average, be said to be Rs. 10 (see Part IV), therefore the cost of 2·17 tons works out at Rs. 21-11-0. Freight from Rangoon to Calcutta Rs. 7 per ton or Rs. 15-3-0 for 2·17 tons. Total cost of raw material, to produce one ton of unbleached pulp in Calcutta, therefore, works out at Rs. 36-14-0.

2. It requires 18 per cent. of caustic soda to reduce 2·17 tons of raw material to one ton of pulp or a total of 7·8 cwts., say, 8 cwts. at Rs. 6 per cwt. of fresh and recovered caustic works out at Rs. 48.

3. Cost of coal, of which 1½ tons are required to produce one ton of pulp, at Rs. 9 per ton = Rs. 13-8-0.

4. Labour, superintendence, Rs. 10.

5. Fixed charges, depreciation, repairs, etc., Rs. 10.

Abstract.

	Rs.	A.	P.
Raw material	36	14	0
Chemicals	48	0	0
Coal	13	8	0
Labour	10	0	0
Fixed charges	10	0	0
TOTAL	118	6	0

Were the pulp to be manufactured in Rangoon, the cost of the raw material would be reduced by Rs. 15-3-0 while the cost of the coal would be increased by Rs. 6-8-0, so that the cost of unbleached pulp in Rangoon works out at Rs. 109-11-0.

Comparing the cost of other unbleached paper-pulp in Calcutta we obtain the following figures:—

Unbleached *Sabai* grass soda pulp, per ton	Unbleached *spruce* sulphite pulp, per ton	Unbleached *bamboo* soda pulp, per ton
Rs. A. P.	Rs. A. P.	Rs. A. P.
162 2 0	150 0 0* to 155 0 0	118 6 0

In calculating the cost of manufacturing bamboo-pulp, various estimates have been put up by experts, based on their laboratory experiments. Raitt, in his report, estimates Rs. 92-8-0 as the cost of preparing unbleached sulphate bamboo-pulp. These figures are for unbleached bamboo-pulp near Rangoon. His figures differ from the above figures in that his chemicals cost Rs. 29-14-0, as against Rs. 48-0-0 in the above estimate, otherwise they are more or less in agreement.† Sindall, on page 43 of his report entitled "Bamboo for paper-making," 1909, estimates the cost of manufacturing bamboo unbleached pulp at £5-10-0, a most optimistic figure.

In arriving at the figure of Rs. 118-6-0 for unbleached bamboo-pulp in Calcutta, it will be seen that all items have been somewhat liberally estimated, probably when extracting bamboos on a large scale it will be found possible to do so for less than Rs. 10 per ton, while the sum fixed for labour and fixed charges, Rs. 20 in all, is a higher figure than that generally adopted by experts.

In spite of the liberal estimate given, the total cost of producing unbleached *bamboo*-pulp works out at Rs. 32 per ton lower than that for imported unbleached *spruce*-sulphite and Rs. 24 per ton lower than the cost of producing unbleached *Sabai* grass-pulp.

* NOTE—This figure includes the manufaturer's profits, while the figures given for Bamboo and Sabai grass soda pulp do not include his profits.

† NOTE.—The reason for the difference in cost of chemicals is that the amount of recovery, as accepted in this report, is based on that obtained when working with grass, whereas Raitt maintains that greater recovery can be expected from Bamboo. His contention is no doubt correct, but until more reliable data are forthcoming on this point it is safer for the present to adopt the higher figure.